2. INVENTORY OF SEGMENTAL PHONEMES

2.1 CONSONANTS

CHART OF CONSONANTAL PHONEMES

	labial	alveolar	palatal	velar	lab-velar	glottal
vl stops	p	t	c	k	kp	
vd stops	b	d	j	g	gb	
vl fricatives	f	s				h
vd fricatives	v					
nasals	m	n	ny		ŋm	
vd continuants		l	y	w		
glottalized consonants	'b	'l	'y	'w		

Glottalized consonants are unique to Birifor, Dagaari, and Busillu Sisaala in Ghana. The following consonants are relatively rare: h, 'b, 'l, 'w and 'y.

2.2 VOWELS

CHART OF VOCALIC PHONEMES

	front	central	back
high [+ATR]	i		u
[-ATR]	ɪ		ʊ
low [+ATR]	e		o
[-ATR]	ɛ	a	ɔ

At each of the nine vowel positions there is contrast in length. There is also contrast in nasalization at each position.

2.3 Phonetic Realization of Segmental Phonemes

2.3.1 Voiceless Stops

/p/, /t/ and /k/ are voiceless bilabial, alveolar, and velar stops respectively. They usually have little or no aspiration. /c/[2] is a voiceless alveopalatal affricated stop. /kp/ is a voiceless labio-velar stop.

2.3.2 Voiced Stops

In their primary realizations, /b/, /d/ and /g/ are voiced bilabial, alveolar, and velar stops respectively.

The contrast of voicing in labial stops is neutralized either utterance-finally (in which case it is unreleased) or word-finally before a voiceless consonant. However, /g/ does not occur in these positions; /d/ is realized as the voiced alveolar flap [r] (see below); and /b/ tends to be realized as the voiceless bilabial stop [p].[3]

/**kab**/ broke	[kap$^{\urcorner}$]	/**wo kab wo naa**/ [wokabwona:] he broke it (V-focus).

The final /b/ also tends to assimilate to the following sound. This can be seen in the verb **tɛb** 'to kick':

/**tɛb**/ kick	[tɛp$^{\urcorner}$]	/**wo tɛb wo naa**/ [wotɛbwona:] he kicked it
/**wo tɛb ma naa**/ [wotɛmmana:] he kicked me (V-focus).		/**wo tɛb fo naa**/ [wotɛffona:] he kicked you (V-focus).

There are not many words with this final /b/, and there is a variance as to how much the contrast is neutralized, both between various speakers and

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[2] In all phonetic representations, c stands for the voiceless palatal affricate (like the English ch) due to the lack on the author's part of a special character for that sound.

[3] With some speakers, there is a free fluctuation between the [p] and [b] in this word-final position.

between the different words. The noun **wɔb** 'elephant' shows the least amount of neutralization and assimilation of the words currently on file:

/wɔb/	[wɔp˺]	**/wɔb puor/**	[wɔppuor]
elephant		elephant's stomach	
/wɔb to:r/	[wɔpto:r]	**/wɔb ɔɔr naa/**	[wɔbɔ:rra:]
elephant's ear		elephant is chewing	[wɔpɔ:rra:]

The final example has a variation, with some people pronouncing the [p] and others the [b]. When followed by a voiced or nasal consonant, the assimilation is sometimes there, and the stop is almost always present, if only to a small degree.

/d/ has five allophones. A voiced alveolar stop occurs morpheme-initially and following a nasal consonant.[4] /d/ surfaces as the voiced alveolar flap [r] following a vowel in non-morpheme-initial positions:

[d]		[r]	
die	room	**ara**	stopped
daka	box	**bara:**	friend
ya-daba	sibling-male	**gbera:**	forehead
banda:	lizard	**sɪrɛ**	husband
bun-di:r	food (thing-eatable)		

Utterance-finally, there are four variants: a voiced alveolar flap, a voiceless alveolar flap,[5] a voiced alveolar trill and a voiceless alveolar trill. While there seems to be some random variation, there is a strong tendency for the voiced allophones to surface following [-ATR] vowels, and the voiceless ones after [+ATR] vowels. There also seems to be a tendency for the flaps to occur after long vowels and the trills to occur after short

[4] The only known exceptions are loan words.

vowels. (All four of these variants are transcribed as r in the phonetic data.)

ana:r	four	**sɔr**	path
'yɛr	said	**yir**	house
banda:	lizard	**gbera:**	forehead
bundi:r	food	**sɪrɛ**	husband

/j/ is voiced palatal affricated stop. /gb/ is a voiced labio-velar stop.

2.3.3 Voiceless Fricatives

/f/, /s/ and /h/ are voiceless labiodental, alveolar and glottal fricatives respectively.

2.3.4 Voiced Fricative

/v/ is a voiced labiodental fricative.

2.3.5 Nasals

/m/, /n/ and /ny/ are voiced bilabial, alveopalatal and palatal nasals respectively. /ŋm/ is a voiced labio-velar nasal.

Word-medial nasals which precede another consonant are always homorganic with it. A voiced velar nasal which occurs phonetically before a velar consonant will be considered an allophone of /n/.

2.3.6 Voiced Continuents

/y/ and /w/ are voiced palatal and velar glides.

/l/ is a voiced alveolar lateral.

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[5] When the voiced alveolar flap is pronounced, the tongue does not always touch the alveolar ridge, often giving this allophone a more fricative quality.

2.3.7 Glottalized Consonants

/'l/, /'y/ and /'w/ are phonetically equivalent to the corresponding plain consonants ([l], [y], [w]) articulated with secondary glottal constriction. Although /'b/ is treated as patterning with the glottalized consonants phonologically, it is realized phonetically as a voiced bilabial implosive stop.

2.3.8 Vowels

Short /a/ is sometimes pronounced as a somewhat higher vowel [ˆ] in fast speech.

3. CONTRASTS IN PHONEMES

The following lists of words demonstrate contrasts among Birifor phonemes. They are presented generally according to the points of articulation.

3.1 Labial and Labio-velar Consonants

		[p]		[b]
initial:	**pɛ̃:**	loan	**bɛ̃:**	beans
	pɛn	rested	**bɪn**	kept
	puo	farm	**bʊɔ**	goat
	pa:la:'	new	**ba:**	dog
	pɔ:	woman	**bulo**	well
medial:	**yapɔ:**	sister	**lub^{i}le**	bird
	yapɔkpɛ̃:'	older sister	**libie**	money
			jambir	tongue
			sɛb^{l}da	pencil

[p] medially occurs only at morpheme-initial boundary.[6]

	['b]	
initial:	**'bɔ:**	picked up
	'bã:	was wet
	'ba:r	shade
	'banta	together
	'bɛl	harvested
	'bɔr	sprained
medial:	**'ba'bʊ'**	garden egg

		[f]		[v]
initial:	**fɪɛl**	wiped	**vɪɛl**	was good
	fa:	escaped	**va:r**	leaf
	fa:n	accidentally	**vakpul**	yam mound
	fɛl	scar	**vɔl**	swallowed
	fɔba:	cloth	**vɪr**	womb
	fu:r	blew	**vʊ:r**	breathed

[f] and [v] do not occur word-medially.

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[6] There are two exceptions to this observation at present: **papa** 'pigeon,' and **sal^{n}pa** 'pounder' (to smooth flat roofs).

	[kp]		[gb]	
initial:	**kpa:r**	back of head	**gba:**	cobra
	kpɛ'	enter	**gbɛr**	leg
	kpaŋkpan	upper arm	**gbatara**	dam
	kpɛ̃:	big	**gbele**	lower leg
	kpɛmɛ	be strong	**gbera:**	forehead
	kpi'	die	**gbʊr**	was near
			gbɔ:	lit fire
medial:	**kpaŋkpan**	upper arm	**gbagba**	duck
	vakpul	yam mound	**suŋgbulo**	bambara beans
	yadakpɛ̃:'	older brother	**gba:ŋgbo**	axe
	dakpo:lɔ̃'	in four days		

	[m]		[ŋm]	
initial:	**man**	river	**ŋman**	calabash
	ma	mother	**ŋma:**	cut
	mal	made	**ŋmã:'**	short
	mire	be sour	**ŋmã:n**	monkey
	mɛ'	molded	**ŋme'**	hit
	mi:r	rope	**ŋmɪnɛ**	how
	mɔ'	stirred T.Z.	**ŋmɛr**	cracked
	mɔntɔ̃:	sun	**ŋmɛrbɪr**	star
			ŋmʊr	compelled
medial:	**gɔmɔ**	chameleon	**na:ŋmɪn**	God
	jama	onion		
	kam:an	corn		
	kpɛmɛ	be strong		
	nɪmbɪr	eye		
	sam:an	pepper		
	sũmo	groundnuts		
	yakarma	older sibling		
final:	**dam**	shook		
	jɪm	fish		
	cʊm	burn		
	pʻlɛm	under		
	wom	suffering		

3.2 Alveolar and Palatal Consonants

	[t]		[d]	
initial:	tɔ:	pull	dɔ:	gave birth
	tar	had	da:	stick
	tɛn	chin	daba	man
	tɪɛ	tree	die	room
	tɪ:	be satisfied	de	collected
	tɵ̃:	village	dɛ:	was dirty
	to:r	ear	dɵ'	bit
medial:	ata'	three	banda:	lizard
	datara'	in three days	bundi:r	food
	gbatara	dam	sɛbʲda	pencil
	mɔntɵ̃:	sun	yadaba	brother
	natɪr	sore		

	[c]		[j]	
initial:	cire	be taboo	jire	gravel
	ca:r	was cleared	ja:'	all
	cɪn	went	jã̈:'	yesterday
	ci	guinea corn	jama	onion
	cuon	sheanuts	jil	xylophone
	cʊm	burned	jie	place
	cɔ:	stabbed	jo	ran
			jɵ	flour
medial:	beca:r	entrance	aja:'	all
	cɛcɛ'	thoroughly	bojɵ̈:	because
	dacin	wall	manjɪɛn	papaya
	pancɵ̃:n	cricket	najɛl	chicken egg
	tɪcɛ	but		

	[l]		['l]	
initial:	la:	bowl	'la:	came apart
	la'	laughed	'lar	axe
	lɔbɔ	a dash	'lɔ'	EMPH 3sg
	lan	passed by	'la:r	hated
	lɛp	turned	'lɪ:	flared
	libie	money	'lor	untied
medial:	ala'	those		
	bʲle	little		
	dakpo:lɵ'	in four days		
	gbele	lower leg		
	pa:la:'	new		
	pele	small basket		

final:	**bal**	be soft
	fɪɛl	wiped
	jil	xylophone
	kpul	corn cob
	mal	made
	piel	began

		[n]		[ny]
initial:	**nã:**	chief	**nyã:**	chest
	nɛ:	mouth	**nyɛ:**	nose
	nɪrɛ	person	**nyɪra:**	ant
	na:	twin	**nya:r**	salt
	na:ŋmɪn	God	**nyɪmɛ**	tooth
	nimbie	eye	**nyɔ:**	caught
	nũ'	loved	**nyɔ̃:**	old
	nũ:	hand		

medial:	**anũ:'**	five	**anya'**	that one
	ŋmɪnɛ	how	**danyaŋgala'**	in five days
	ɪnsʊɔ'	one	**kanyir**	patience
	kono	cried	**tanyɔ̃**	ant
	mɔntɔ̃:	sun		

final:	**bɪn**	kept
	dacin	wall
	ŋmã:n	monkey
	jan	taught
	gɔ:n	was bent
	nʊn	meat
	pɛn	rested

		[y]		['y]
initial:	**yɛr**	spread	**'yɛr**	said
	yir	house	**'yɛmɪntĩɛ̃**	tomatoes
	yaba	neighbor	**'yɛn**	hippopotamus
	yi'	went out	**'yɔ̃:**	put in
	yɔ'	roamed	**'yɔla:**	certain berry
	yuor	water pot		

medial:	**dayõ**	rat	**na:'yɔ:**	pumpkin
	ayi'	two	**bʊ'yɛn**	one
	dayɪrɪ'	in two days	**nu'yɔ:**	lower arm
	dɪ:yɛ̃'	last year		

3.3 Velar Consonants

	[k]		[g]	
initial:	**kã:**	oil	**gã**	laid down
	kul	got married	**gur**	slept
	ku:r	hoe	**gar**	roof
	kap	broke	**gel**	was crazy
	kʊ'	kill	**gʊba:**	left
	kɔ:lʊ̃	feather	**gɔmɔ**	noise
medial:	**daka**	box	**danyaŋgala'**	in five days
	dakɔ:	chair	**ɪŋgan**	body
	duŋkur	back	**gaŋga:**	drum
	kakɪr	stalk		

	[w]		['w]	
initial:	**wɔp˥**	elephant	**'wɔp˥**	chewed
	wa'	came	**'wɔrɔ**	certain berry
	wa:	snake	**'wɔ̃**	smoked (meat)
	wɛr	world	**'wɔl**	cry w/o reason
	wʊ̃	heard		
	wʊ̃:'	tall		
medial:			**bɔ̃'wa:**	hawk
			nya'wolo	cat

3.4 Other Consonant Contrasts

	[s]		[h]	
initial:	**san**	debt	**han**	sweated
	sa:la:	sharp'ng stone	**ha:**	opened (mouth)
	sɛ̃:	was full	**ha:r**	chased away
	sɪrɛ	husband	**hi:r**	yawned
	sʊ:r	asked	**hɪl**	lantern globe
	sɔ̃:	rabbit		
medial:	**ɪnsʊɔ'**	one		
	kʊsɪr	stone		
	nasa:l	white man		
	nʊsʊ̃ɔ̃	right		

3.5 Oral Vowels

	[i]		[i:]	
open syl.	ci	guinea corn	di:	chased
	bibi:r	children	li:	was dark
	cire	be taboo	vi:	owl
	libie	money	wi:	horse
closed syl.	jil	xylophone	ci:n	be going
	yir	house	kpi:n	extinguished
			mi:r	sour

	[ɪ]		[ɪ:]	
open syllable	sɪrɛ	husband	sɪ:	bee
	dɪna'	today	'lɪ:	lit (match)
	nɪbɛ	people	tɪ:	be satisfied
	nɪrɛ	person		
closed syllable	jɪm	fish	pɪ:r	swept
	kakɪr	stalk	pɪ:r	wing
	kʊsɪr	stone	tɪ:r	heavy
	nyɪm	tooth	wɪ:r	exhaled quickly

	[e]		[e:]	
open syllable	de	collected	gbe:	legs
	gbele	lower leg		
	ŋmera:	month		
	gbera:	forehead		
	ŋmera:	month		
closed syllable	ŋmerbie	stars	kpe:r	heart
			le:r	blistered

	[ɛ]		[ɛ:]	
open syllable	kpɛmɛ	be strong	dɛ:	be dirty
	nɪbɛ	people	nɛ:	mouth
	nyɪmɛ	tooth	nyɛ:	nose
	sɛbᵗda	pencil	pɛ:	washed
closed syllable	gbɛr	leg	bɛ:r	tested
	ŋmɛr	cracked	dɛ:r	dirty
	jɛl	sifted	pɛ:r	shell, bark
	lɛp	turned	pɛ:l	fruited
	pɛn	rested		

		[a]		[a:]
open syllable	ta	reached	na:	chief
	ba	3pl pronoun	ba:	dog
	ara	stopped	gba:	cobra
	dacin	wall	ŋma:	cut
	samɪna	soap	sa:la:	sharpening stone
closed syllable	kap	broke	ana:r	four
	'lar	axe	fa:n	accidentally
	mal	made	ja:'	all
			sa:n	stranger

		[ɔ]		[ɔ:]
open syllable	bɔlɔ	kind of fruit	bɔ:	hole
	fɔba:	cloth	dɔ:	gave birth
	lɔbɔ	a dash	kɔ:lɔ̃	feather
	kɔkɔr	language	nyɔ:	held tightly
	bʊrɔ	kinds	'ɔ:	flew (bird)
closed syllable	yɔ'	roam	yɔ:'	many
	sɔr	path	sɔ:r	liver
	lɔp	dashed	nu'yɔ:	lower arm

		[o]		[o:]
open syllable	bojũ:	because	dakpo:lɔ̃	in four days
	gboro	canoe	to:	lifted off of head
	kpolo	termites	co:	bird's nest
closed syllable	for	tied	to:r	ear
	lombo:r	side	bo:r	granary
			kpo:r	knocked

		[ʊ]		[ʊ:]
open syllable	bʊrɔ	kinds	dʊ:	pot
	bʊ'yɛn	one	kʊ:	gave
	dʊrɔ̃	right	mʊ:	sucked (fruit)
	gʊba:	left		
	kʊ'	killed		
closed syllable	bʊlsi	well	pʊ:r	small
	bʊn	thing	dʊ:l	put on the fire
	kʊr	kept long	jʊ:r	tail
	nʊn	meat	sʊ:r	asked
			vʊ:r	breathed

		[u]		[u:]
open syllable	ju	on	bu:	was drunk
	lubⁱle	bird	du:	swam
	nu'yɔ:	lower arm	fu:	shirt
	suŋgbulo	bambara beans	nu:	hand
closed syllable	kul	got married	ku:r	hoe
			bu:l	porridge
			fu:r	blew
			nyu:r	yam

3.6 Nasalized Vowels

		[ɪ̃]		[ɪ̃:]
open syllable	vɪ̃	shame	pɪ̃:	arrow

		[ʊ̃]		[ʊ̃:]
open syllable	mʊ̃	also	jʊ̃:	blood
			tʊ̃:	medicine
			sʊ̃:	awakened
			cʊ̃:	to fry
closed syllable	jʊ̃'	equal		
	nyʊ̃'	decorated		

		[ə̃]		[ə̃:]
open syllable	gə̃gelaa	crazy person		
	də̃fere	lightweight		
	pə̃pelaa	butterfly		

		[ɛ̃]		[ɛ̃:]
open syllable	vɛ̃	allowed	bɛ̃:	beans
	jɛ̃	sat	pɛ̃:	loan
	yɛ̃	common sense		
closed syllable	sɛ̃'	roasted	kpɛ̃:'	big
	dɩ:yɛ̃'	last year		

		[ã]		[ã:]
open syllable	gã	laid down	kã:	oil
			'bã:	to be wet
			nã:	chief
			ŋmã:'	short
			sã:	father
closed syllable	pã'	pound (roof)	jã:'	yesterday

Note that nasal and oral vowels may contrast after nasal as well as oral consonants, cf. nã: 'chief' with na: 'twin' (see list for [a:] on page 13, both with low tone.

		[ɔ]		[ɔ:]
open syllable	jɔ	flour	jɔ:	blind man
	tanyɔ	ant	bɔ:	knew
			nyɔ:	old
			'yɔ:	put in
			sɔ:	spoiled
closed syllable	nɔ'	kneaded		

		[ɔ̃]		[ɔ̃:]
open syllable	dayɔ̃	rat	yɔ̃:	outside
			kɔ̃:	be thin (sickly)
			tɔ̃:	village
closed syllable	wɔ̃'	heard	wɔ̃:'	tall
	dakpo:lɔ̃	in four days		

		[ʊ]		[ʊ:]
open syllable	dʊrʊ	right	fʊ:	EMPH, 2sg
	kɔ:lʊ	feather	sʊ:	helped
closed syllable	dʊ'	bit		
	tʊ'	worked		

		[ũ]		[ũ:]
open syllable	sũmo	groundnuts	bũ:	fire
			bojũ:	because
			kũ:	death
			nũ:	hand
			'ũ:	to bury
closed syllable	lũ'	tied	anũ:'	five

Nasalized vowels contrast with vowel-plus-nasal consonant[7] sequences in word-final positions:

mã	mother	**san**	debt
dã:	local beer	**dam**	shoook
pɛ̃:	loaned	**pɛn**	rested
jɪ̃	equal	**jɪm**	fishh
wõ'	heard	**wom**	suffering
sʊ̃'	good	**cʊm**	burned

This contrast is neutralized in non-word-final position; only vowel-plus-nasal consonant sequences occur in this environment. See Section 4.1.2.4 for further discussion.

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[7] While all vowels are phonetically somewhat nasalized before a nasal consonant, this nasalization is not contrastive and does not seem to be as strong as that of the contrastively nasalized vowels which occur in other environments. It has therefore not been marked in the phonetic data.

4. Phonotactics

4.1 Syllable Structure

4.1.1 Clear Syllable Patterns

The unambiguous syllable patterns are CV and CVC. All consonants can occur syllable-initially. Only /n/, /m/, /l/, /d/ (realized as [r]) and /b/ (realized as [p˺]) occur syllable-finally. Examples of these patterns are shown below.

CV		CVC	
ma	mother	**ŋman**	calabash
ci	guinea corn	**jil**	xylophone
jɔ̃	flour	**wɔp˺**	elephant
bɛ̃:	beans	**pɛ:r**	shell, bark

4.1.2 Problematic Sequences.

4.1.2.1 Long Vowels

Long vowels occur in both closed and open syllables:

CV:		CV:C	
ba:	dog	**mi:r**	rope
kɔ̃:	guinea fowl	**dɛ:r**	dirty

Long vowels could be interpreted either as single unit phonemes or as vowel sequences. The clear CV(C) syllable structure argues for treating the long vowel as a single unit. However, an analysis of the tone (Kuch, unpublished) shows that while contour tones do not occur on single short vowels, long vowels appear to be two tone-bearing units:

jã:' (LH) yesterday **mi:r** (HL) sour

mã: (LH) emph. pn, 1 sg. **sɔ̃:** (HL) rabbit

Recent autosegmental theories (cf. Clements and Keyser, 1983) offer yet a third possibility: long vowels may be analyzed as single segments linked to

two timing elements on an autosegmental timing tier. This type of representation predicts that long vowels should pattern as vowel sequences with respect to their tonal behavior, since each of the two timing elements to which they are linked can be associated with a different tone. At the same time, the fact that they consist of single units on the segmental tier predicts that they should act like single vowel segments in other respects. Accordingly, I will interpret long vowels as a single segment linked to two timing elements on an abstract timing tier. For simplicity of exposition, I will hereafter represent them by doubled vowel letters in both phonetic and phonemic transcriptions.

4.1.2.2 Vowel-initial Words

There are two general areas where potential V syllables occur: word-initially and in certain grammatical morphemes.

When utterance-initial, all words that have no other consonant preceding the first vowel are pronounced with an initial glottal stop:[8]

'ayi' two 'ɪ:n to forget 'ɔ: mouse

When these word-initial glottal stops occur utterance-medially, they often disappear in some environments in fast speech.

There are several possible interpretations to the glottal stop in this position. The glottal stop might be treated as phonemic, causing these words to follow the clear CV(C) syllable pattern both phonetically and phonemically. Or, these words might be regarded as phonemically vowel-initial, with the glottal stop inserted by a rule. This would imply that the word-initial syllables are phonemically V(C) but phonetically CV(C).

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[8] Out of a sample of 360 words, 25 had a glottal stop utterance-initially.

A third possibility is suggested using an autosegmental model such as that of Clements and Keyser (1983). In this approach, the initial glottal stops could be treated as the phonetic realization of an empty C position (cf. Michelson, 1985) on the timing tier. Thus these words could be represented with initial CV(C) syllables both phonetically and phonemically. I will therefore adopt this third interpretation; however, since these glottal stops are predictable, they will only be written in the phonetic data.

Word-final glottal stops are discussed below in Section 4.1.2.6.

4.1.2.3 Sequences of Dissimilar Vocoids

4.1.2.3.1 Sequences in which the first vocoid is high

Birifor contains a number of vocoid sequences, **ie**, **ɪɛ**, **uo** and **ʊɔ**. They occur both within single morphemes as well as across morpheme boundaries:

vɪɛl	was good	**bʊɔr**	wanted	**puor**	greeted
die	room-SG	**bʊɔ**	goat-SG	**kʊ̃ʊ̃**	water-SG

These sequences might be interpreted either as genuine vowel sequences or as two vowels with an intervening glide.[9] This latter interpretation is

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[9] Another possibility is that the sequences of dissimilar vocoids could be interpreted as underlying long vowels which surface as vocoid sequences through a process of diphthongization. A difficulty for this analysis is that there are at least a few examples where these sequences contrast with the long vowels to which they are most phonetically similar:

tuo	lifted onto head	**sʊɔba**	witch
tu:	dug a hole	**dʊ:**	cooked
to:	took off of head	**sɔ:**	rinsed

In present-day Birifor, all of these words seem to consist of single morphemes.

possible because the first vocoid in each of the sequences is high. If adapted, these forms would be written as:

vɩyɛl	was good	**bʊwɔr**	wanted	**puwor**	greeted
diye	room	**bʊwɔ**	goat	**kʊ̃w3̃**	water

Since there are no unambiguous vocoid sequences, i.e. ones in which neither member is a high vowel (such as **aɔ**, **ɔɛ**), the clear syllable pattern of CV(C) supports the conclusion that these sequences belong to two syllables separated by a glide.

Morphological considerations can also shed some light on this issue. There are some grammatical morphemes which seem to consist of a single low vocoid. One example is the negative marker, a clitic which attaches to the last word of a negative clause. The following examples show this marker after stems ending in a consonant and those ending in a high vowel:

wa cɛnɛ
He went-NEG
He didn't go.

wa malɛ
He made-NEG
He didn't make (it).

wa tɩɛ
He came-NEG
He didn't come.

wa cɩɛ
He chiseled-NEG
He didn't chisel.

The forms with consonant-final stems seem to indicate that the negative marker should be analyzed as **ɛ** rather than **yɛ**, since no glide surfaces in these forms.[10]

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[10] This morpheme can also surface as **e** after **i** or **u** due to vowel harmony: **wa die** (he ate-NEG).

However, when the preceding vowel is low, the negative marker takes the phonetic shape of a high front nonsyllabic vocoid (here transcribed as a raised ɩ):

wa waˈ	**wa dɔːˈ**
He came-NEG	She gave birth-NEG
He didn't come.	*She didn't give birth.*

This vocoid could be interpreted either as a vowel (ɩ) or a consonant (y); the latter interpretation conforms more closely to the clear syllable pattern CV(C).

Similar behavior can be seen in the plural suffix of the class H nouns.[11] In the examples below, the plural morpheme is shown first following high vowel-stems and then following low vowel-stems (no consonant-final stems have yet been found in this noun class):

yie	house-PL	**kakɩɛ**	stalk-PL
sɔˈ	path-PL	**vaːˈ**	leaf-PL

Here we see two cases in which a morpheme that could be analyzed as consisting of a low vowel in some contexts fail to surface as such when it follows a dissimilar low vowel. This could be coincidence; however, it is worth noting that if the suffixes **had** been realized as low vowels after dissimilar low stem vowels, this would have led to sequences (e.g. **sɔɔɛ**, **vaaɛ**) which could not be analyzed as consisting solely of CV(C) syllables. This suggests that Birifor has a strong tendency to maintain the canonic syllable pattern of CV(C), a tendency which is consistent throughout the language. Even where there are classes of stems which end in low vowels and which can take suffixes which have allomorphs that seem to consist of

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[11] There are nine classes of nouns, labeled A-I, based solely on their singular-plural forms.

single low vowels, these never actually result in phonetic sequences of two dissimilar low vocoids, i.e., in sequences which **must** be interpreted as genuine vowel sequences. In view of this, I will interpret all **ie**, **ɪɛ**, **uo**, and **ʊɔ** sequences as VGV (using G as the 'glide' subclass of consonants--/y/ and /w/). Although this will require positing an additional allomorph **yɛ** of the negative marker after high vowel stems, it will result in a simpler statement about the syllable structure.

4.1.2.3.2 Sequences in which the second vocoid is high

There are a few situations in which a vocoid sequence is composed of a low vocoid followed by a high vocoid. Two of these cases, involving the negative marker and the plural suffix of noun class H, have already been discussed above. A further example can be seen in the behavior of the yes/no question marker, which surfaces as **ɔ** after a consonant, but as a high round non-syllabic vocoid after the low vowel **a**:

wʊ da na: mi:r ɔ	**wʊ wa na^{ʊ}**
he bought rope-Q	he came-Q

In light of the discussion in the preceding section, and to conform to the clear syllable pattern of CV(C), these vocoid sequences will be interpreted phonetically as vowel-glide sequences.

4.1.2.4 Nasal Sequences Word-medially

In Section 3.6, I discussed the contrast between nasal vowels and showed contrast between nasal vowels and vowel-plus-nasal consonant sequences in word-final position. In non-word-final position, contrast is neutralized: only the latter occur in this environment.[12]

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[12] One exception has been found, **bɔ̃'wa:** 'hawk'.

While the most obvious analysis is to consider this sequence as /VN/, there is reason to believe this may not be the best analysis. In the process of determining syllable structure, I attempted to train my language helper to divide words by syllables. When asked to divide words which contain a CVNCV sequence, he pronounced the first syllable as having a nasal vowel only, with no nasal consonant whatever (for example, **banda:** 'lizard' was divided as **bã - da:** rather than **ban - da:**). While this is not any proof in itself, it points to the possibility of a vowel-plus-nasal consonant sequence being a nasal vowel underlyingly.

Further evidence can be seen in a process which occurs across morpheme boundaries. When an underlying morpheme-final nasal vowel is followed by a morpheme beginning in a non-nasal consonant in fast speech, the phonetic result is often a CVN syllable. The following examples show this happening with the noun class C plural suffix **-sɩ** and the adjective **kpɛ̃:** 'big':

sɔ̃:	rabbit-SG	**sɔ̃nsɩ**	rabbit-PL
jɪ̃:	blood-SG	**jɪ̃nsɩ**	blood-PL
lɔ̃:	frog-SG	**lɔ̃ŋkpɛ̃:**	frog-big

Hence there is additional evidence for a process which converts an underlying nasalized vowel to a surface VN sequence before a non-nasal consonant.[13] In view of this evidence, I will analyze the phonetic sequences of a vowel-plus-nasal consonant in non-word-final position as underlying long nasal vowels.

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[13] The plural forms of **sɔ̃:** and **lɔ̃:** are **sɔ̃n** and **lɔ̃n**, respectively. This shows a contrast between a final nasalized vowel and a nasal vowel-final-n combination.

4.1.2.5 Consonant Clusters

4.1.2.5.1 Cl and Cr clusters

Phonetically, CCV(C) syllables sometimes occur in fast speech. The initial consonant cluster always involve a labial consonant followed by [l] or [r]. Examples include [**ble**] 'small' and [**vla**] 'beautiful.' In slower speech, these are sometimes pronounced with a short high vowel: [b^{i}**le**] and [v$^{\iota}$**la**]. Since there are no clear examples of syllable-initial consonant clusters in Birifor, I will interpret this potential consonant cluster as having an intervening vowel. Thus the resulting syllable pattern of these words is CVCV.

4.1.2.5.2 Glottalized Consonants

There are a small number of consonants in Birifor that are not found in most of the other languages in Ghana. They are /'**b**/, /'**l**/, /'**w**/, and /'**y**/. These can be interpreted as either a consonant cluster or as one unit. As mentioned above, there is a lack of clear evidence for consonant clusters, and so these will be analyzed as single units.

4.1.2.5.3 Geminate Consonants

This area has been examined through the use of the S.I.L. Speech Analysis System (CECIL). Numbers in parentheses are the length, in milliseconds, of the underlined consonant. All measurements were made from the tape recorded speech of the same speaker who was using a careful, but not unnatural, rate of speech.

Phonetically long consonants arise through several sources:

1. When two identical consonants are juxtaposed across word boundaries, the result is a long consonant:

Utterance	Phonetic Rep.	Length of C	Gloss
lubil lɛ	[lubi$_{l:ɛ}$]	181	birds there-are
lubile	[lub^{i}le]	76	bird-SG

2. Long consonants can also arise through the total assimilation of an initial alveolar consonant of certain morphemes, e.g. the particle **naa**:

Utterance	Phonetic Rep.	Length of C	Gloss
n jɛl naa	[njɛl:a:]	105	I sifted ---
n jɛlɛ naa	[njɛlɛna:]	61	I am-sifting ---

3. The length of sonorants is sometimes contrastive intervocalically within single morphemes:

sam:an	(133)	pepper	**gɔmɔ**	(82)	chameleon
kam:a:n	(126)	corn	**kpɛmɛ**	(83)	to be strong
sa:l:a	(129)	sharpening stone	**gbele**	(74)	forehead

Phonetically long consonants will be treated as a sequence of two identical consonants. This is supported by the fact that some long consonants clearly arise from two separate consonants underlyingly (see 1 and 2 above). Further evidence is that these long consonants only occur intervocalically, adhering to the canonic CV(C) syllable structure when interpreted as C.C.

4.1.2.6 Final Glottal Stop

With few exceptions, all monosyllabic verbs which consist of a consonant followed by a short vowel are realized with a following glottal stop in utterance-final position. All other verbs are pronounced without a final glottal stop utterance-finally:

With Glottal Stop		Without Glottal Stop	
ŋmɛ'	hit	kpɛmɛ	was strong
kpɛ'	entered	tɪ:	be satisfied
la'	laughed	pɛ:	washed
kɔ'	hoed		

The glottal stop does not appear after nouns at all. Its occurrence in other classes has not yet been fully investigated; however, since the final glottal stop is predictable in both the nouns and the verbs, I will tentatively assume that it is non-phonemic.

4.2 Morpheme and Word Structure

Although this area still requires further investigation, a number of observations can be stated:

1. Few noun roots consist of more than two syllables.

2. The vowels in the noun roots have a strong tendency to be either all high or all non-high.

3. There are no verb roots consisting of more than two syllables. Approximately twenty percent are disyllabic and the rest are monosyllabic.

4. There do not appear to be any restrictions on the occurrence of CV and CVC syllables in words -- both syllable types may occur freely in all positions.

4.3 Distribution of Phonemes

1. There are no examples in the data of **f**, **v**, **h**, and **ŋm** occurring intervocalically within single morphemes.

2. There are also no examples of **'l** intervocalically within a morpheme. However, this may well be due to lack of data since this phoneme is relatively rare to begin with, and the other preglottalized sonorants (**'b**, **'w** and **'y**) all do occur intervocalically within morphemes, though seldom.

3. There do not appear to be any restrictions as to which consonants may precede which vowels, nor as to which of the permissible syllable-final consonants may follow which vowels within the same syllable.

4.4 Vowel Harmony

Birifor has Advanced Tongue Root vowel harmony. As a result, there are two harmony sets of vowels: **i**, **e**, **u**, **ɔ** (advanced tongue root) and **ɪ**, **ɛ**, **ʊ**, **ɔ** (non-advanced tongue root). In any one morpheme, only members from one set may be present. Thus, we have:

nɪrɛ	person	**mire**	to be sour
bʊ'yɛn	one	**bulo**	well

but not ***nirɛ**, ***mɪre**, ***bo'yɛn**, or ***bulɔ**.

Although phonetically non-advanced, the low vowel **a** is unique in that it may be paired with vowels from either set:

dakɔ:	chair	**dayõ**	rat
nyɪra:	ant	**ŋmera:**	moon

Most affixes also conform to vowel harmony. This can be seen in the behavior of the noun class I singular and the noun class D plural suffixes, which harmonize with the preceding stem vowel:

Class I singular		Class D plural	
duo	pig-SG	jile	xylophone-PL
bʊɔ	goat-SG	jɪmɛ	fish-PL

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